

CHEMICAL AND BIOLOGICAL BARRIER MATERIALS FOR COLLECTIVE PROTECTION

Kristian Donahue

Chemical Engineer

U.S Army Soldier and Biological Chemical Command

Natick, MA

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OVERVIEW

PURPOSE

□ Educate

*** BACKGROUND**

☐ Brief History of CB Barrier for Collective Protection

***TECHNOLOGY DEVELOPMENT AREAS**

- □ Near-Term Solution

 □ Near-Term Solu
- ☐ Long-Term solution

❖ WHAT NEXT?

□ Collaborative Effort



BACKGROUND

ColPro Shelters

- *Heavy
- *Cumbersome
- *High Logistic Burden
- *Very Expensive

Barrier Materials

- *Butyl Rubbers
- *Chlorinated Aliphatics
- *Fluorinated Polymers

Characteristics of a Barrier Material

Permeability of a "Challenge Agent"

VS.

- * Thermal Stability
- * Flame Resistance
- * Ease of Decontamination
- * Longevity
- * Leakage Points
- * Weight
- * Durability (Flexibility, Abrasion, Crackle)
- * Cost

DEGREE OF PROTECTION?



CHEMICALLY PROTECTIVE BARRIER

NO BARRIER IS PERFECT

Threat Permeability?

Polarity
Chemical Structure
Size of Molecule
Driving Force (Concentration)
Temperature

Properties of Barrier Film

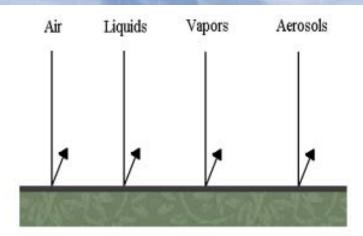
- -Material
- -Thickness
- -Inertness
- -Condition

SEVERAL COMPONENTS

- → Base Material or Substrate

 *Provides Physical Properties
- →Impermeable Barrier

 **Provides CB Protection





HISTORY

M51

1St ColPro Shelter System -1960's

№ Neoprene/Dacron/Tedlar®

Effective Barrier Material?

✓ YES

100 minutes for Mustard (HD) 200 minutes for GB (Sarin)



M51 Collective Protective Shelter





M51 DEFICIENCIES

X Logistically Burdensome

- 5,700 lbs.
- Took 5 persons 30+ minutes to erect
- Needed generator/blower to run 24/7

H Material Flaws

- Expensive \$\$\$
- Difficult to weld/bond
- Heavy
- \rightarrow Tedlar $^{\mathbb{R}}$
 - * Flex Cracking (Folding, Cold)
 - *Abrasion
 - × Dedicated Vehicle







WHAT NEXT?

1980's Investigation



*Need New CB Material

*2 Areas Investigated

*★***Outer Shelter Skin**

✓ Inner Liner Material



CANDIDATE MATERIALS

✓ Butyl Nylons

èTeflon Kevlar®

Tedlar/Vinyl coated Dacron®

Teflon/Nomex®

✓ Polyester/Tedlar/Kevlar

RDECOM

Collective Protection Directorate



TEFLON KEVLAR®

* CHARACTERISTICS *

- ✓ CB Resistance
- ✓ Flammability
- ✓ Weight
- √ Flexibility
- ✓ Durability
- ✓ Manufacturability
- √ Cost
- ✓ Decontamination





TEFLON KEVLAR®

SUPERIOR QUALITY

- **CB** Resistance
- > Weight
- > Mechanical Properties
- **Decontaminable**
- > Heat-Sealable

HOWEVER...

\$\$\$ High Cost \$\$\$

- *Manufacturing
- *Material



Chemical and Biological Protective Shelter (CBPS)



M28 LINER MATERIAL

→ Secret Service *M20

Adopted for GP shelters

Over Pressured Liner

Material

*PVDC or Saranex Barrier Film

*HDPE Scrim

*LDPE Coating (Protect Barrier)

Lightweight Inexpensive Solution

Increased

- ✓ Weight
- √ Packing Volume
- ✓ Deployment Time





2 OPTIONS AVAILABLE

Teflon/Kevlar®

- *Superior Protection
- *Lightweight
- *Decontaminable
- *Flame Resistant

HOWEVER...

\$\$EXPENSIVE\$\$



OR

PVDC/PE (M28)

* Inexpensive
*Provide CB Protection for GP Shelters

HOWEVER...

*Increase Weight
*Increase Deployment Time
*Increase Packing Volume
*Not Decontaminable





TECHNOLGY DEVELOPEMENT

Joint Science and Technology Panel for CB Defense

*****Investigate/Develop Next Generation CB Material

GOAL->

- ✓ Lightweight Composite Material
- √ UV/Flame Resistant
- ✓ Increased Durability
- ✓ Improved Permeation Properties
- ✓ Decreased Cost (Material & Manufacturing)



MITIGATE RISK



Incremental Improvements

3 Pronged Approach

* Near-Term Solution

-Fluoropolymer Coating/Lamination of GP Fabrics

- * Mid-Term Solution
- Nanotechnological Enhancement of Polymers
- Low-Temperature Processible Fluoropolymers
 - * Long-Term Solution
 - Self-Decontaminating Barrier Materials



NEAR-TERM SOLUTION

Improving Barrier Properties of General-Purpose Fabric

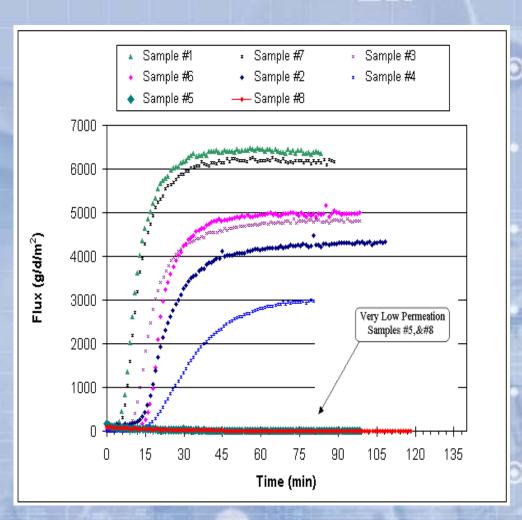
Polyester with PVC Coating *Apply Coating or Laminate

Duracote Corporation

- Various Laminates
- Very Promising Results

TCE Simulant
Typical GP Fabric= 17,000 g/d/m²

BUT...Delamination



Tetrachloroethane (TCE) Permeation Through Laminated GP fabric



VENTANA RESEARCH

CB Barrier Coatings For GP Shelter Fabric

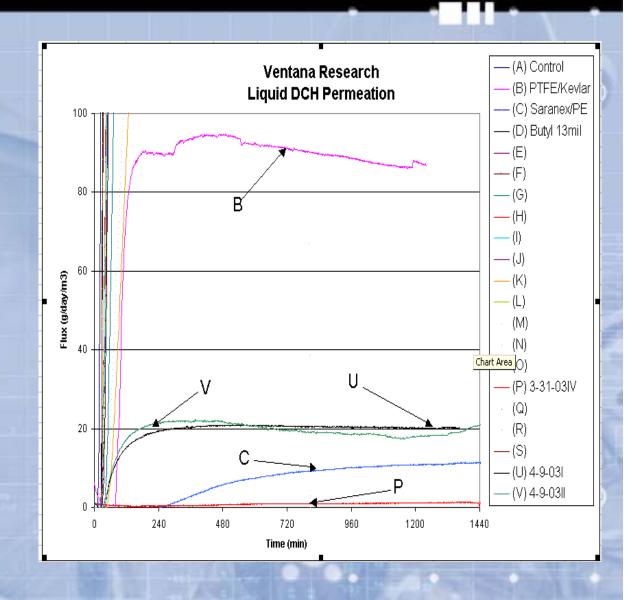
*Low cost

*Water Soluble

*Environmentally safe

*Easy to apply







MID-TERM SOLUTION

Goal: Transition in 2-4 yrs.

Current Programs

*****Nanocomposite Films

*Low-Temperature Processible Fluoropolymers



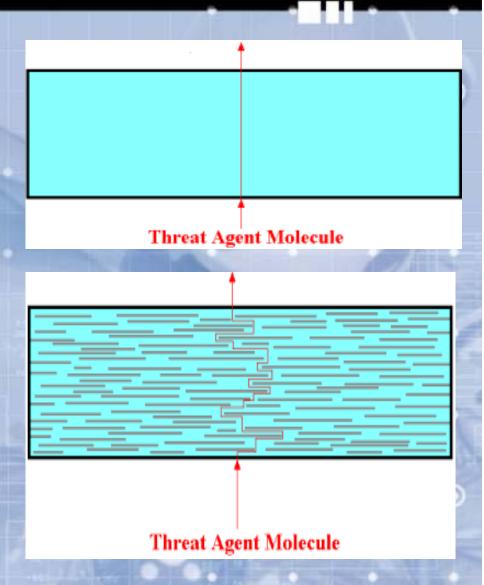




NANOCOMPOSITE FILMS

Background

- S Novel patented nanotechnology is based on the use of minute levels (1-5%) of chemically inert inorganic fillers that exhibit a platelet nanostructure
- S Adjustment of chemistry and processing conditions allows nanofillers to self-assemble (stack up) through the thickness of the plastic sheet and parallel to the plane of the barrier film
- S High aspect ration creates a tortuous path for the diffusing chemical species
- Increased distance = Increased time for diffusion through thickness of the plastic



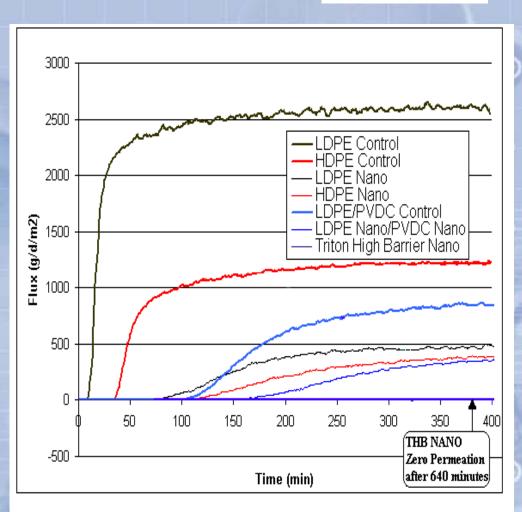


TRITON SYSTEMS INC.



Accomplishments

- H Synthesized several nanocomposite films that have shown up to 5X improvement in barrier to CB simulants compared to unfilled barrier films
- H Layered silicates act as a passive flame retardant
 - → Act as a barrier to the flame by the formation of a ceramic or glassy layer on the surface of the polymer
 - → High gas barrier also prevents oxygen from feeding the flame, thus starving the fire





TRITON SYSTEMS INC.





LIVE AGENT TESTING

H Developed a multi-layer laminate system that achieved greater than 24-hour exposure to liquid HD mustard chemical agent with NO penetration

| | Sampling Intervals (Hours from Start) | | | | | | | | | | |
|---|---------------------------------------|---------|-------|-----|-------|-----|--------|---------|---------|---------|------------|
| | (µg/cm²) | | | | | | | | | | |
| | Agent | Sample | (0-2) | (2- | (4-6) | (6- | (8-12) | (12-24) | (24-48) | (48-72) | Cumulative |
| | | | | 4) | | 8) | | | | | |
| | D | Neat | ND | ND | ND | ND | ND | ND | 0.1 | 0.15 | 0.25 |
| | | TSI | ND | ND. | ND | ND | ND | ND | ND | 0.2 | 0.2 |
| | | Barrier | | | | | | | | | |
| 5 | | Film | | | | | | | | | |
| | GB | Neat | ND | ND | ND | ND | ND | 0.00016 | 0.00036 | 0.00037 | .00089 |
| | | TSI | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | | Barrier | | | | | | | | | |
| | | Film | | | | | | | | | |



TRITON SYSTEMS INC.



CURRENT EFFORTS:

Scaling up Technology→ Prototype Shelters

- ✓ Non-Decontaminable Barrier Liner Material
- ✓ Decontaminable High Barrier CB Outer Skin Fabric



LOW-TEMP PROCESSIBLE FLUOROPOLYMERS

ARAMIDS (KEVLAR, NOMEX etc.)

- √ High Strength
- ✓ Light Weight BUT...
 - *High Cost



Needed to Survive the High Temperature During Manufacturing

Low-Temperature Fluoropolymer = Lower Cost Substrate



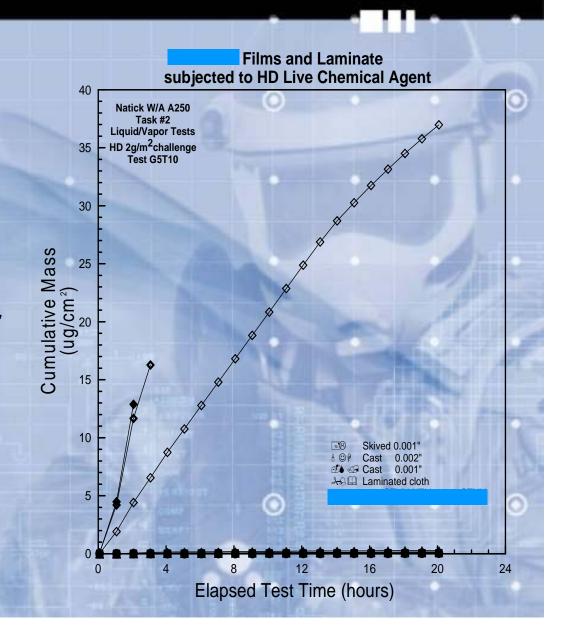
FEDERAL FABRIC-FIBERS INC.

Work From building blocks

Create:

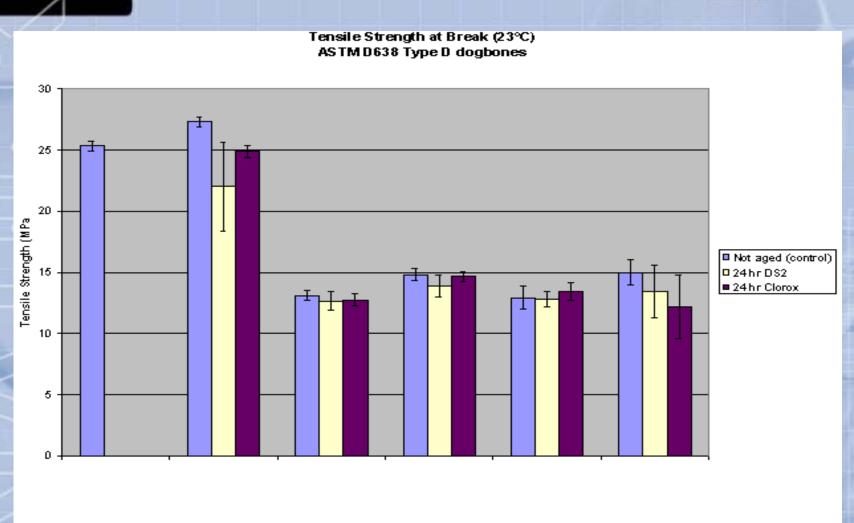
*Void Free Fabric
Substrate
*CB Resistant Barrier

- → Low Cost
- → Lightweight
- → Decontaminable



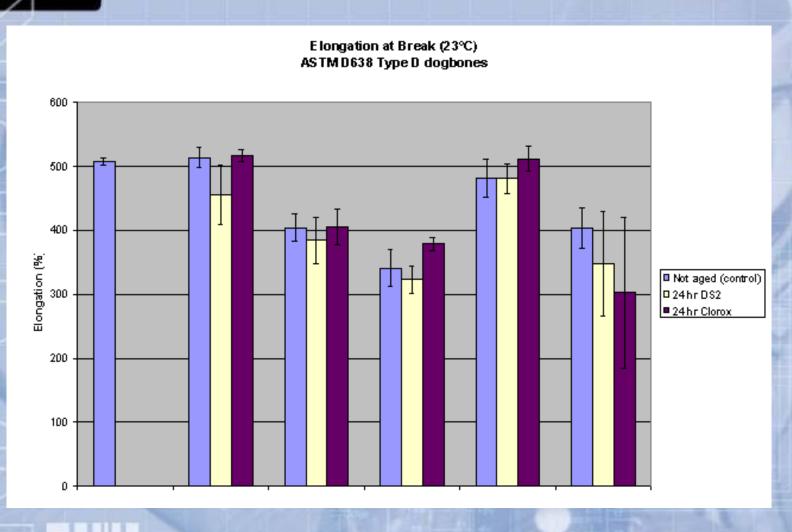


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CURRENT EFFORTS:

✓ Have equipment in place and have completing a limited production run

Production?

Improving:

Efficiency

Quality

Consistency of entire process



LONG-TERM SOLUTION

Self-Decontaminating Barriers Incorporating **Catalytically Reactive Membranes**

*Newly funded program with Ventana Research



TECHNOLOGY WATCH

- **✓** Academia
- ✓ Industry
- √ Government
- **Foreign Military**





CONCLUSION

2 Currently available Options

- → Kevlar/Teflon
- →M28 Liner (PVDC/PE)

Mitigate Risk

Near-Term Solution

Coated/Laminated Barrier Fabric

Mid-Term Solution

Integrating Nanocomposites into Commodity Polymers Low-Temperature Processible Fluoropolymers

Long-Term Solution

Self-Decontaminating Barrier Materials Incorporating Catalytically Reactive Membranes

>Need to work together to bridge technology gaps and identify novel solutions

